

Claims

- [c1] An apparatus for reducing the post-detonation pressure of a perforating gun, the apparatus comprising:
a perforating gun carrying at least one explosive charge, wherein when the explosive charge is detonated the explosive charge produces a pressurized detonation gas;
a pressure reducer in functional connection with the perforating gun, the pressure reducer adapted to reduce the pressure of the detonation gas.
- [c2] The apparatus of claim 1 wherein the pressure reducer is positioned proximate the perforating gun.
- [c3] The apparatus of claim 1 wherein the pressure reducer is positioned disposed in the perforating gun.
- [c4] The apparatus of claim 1 wherein the pressure reducer is part of the perforating gun.
- [c5] The apparatus of claim 1 wherein the pressure reducer includes a heat sink adapted for rapidly reducing the temperature of the detonation gas.
- [c6] The apparatus of claim 5 wherein the heat sink has a high thermal conductivity.

- [c7] The apparatus of claim 5 wherein the heat sink has a large heat capacity.
- [c8] The apparatus of claim 5 wherein the heat sink includes copper.
- [c9] The apparatus of claim 5 wherein the heat sink includes water.
- [c10] The apparatus of claim 5 wherein the heat sink includes microencapsulated water beads.
- [c11] The apparatus of claim 1 wherein the pressure reducer includes a reactant adapted for recombining with the detonation gas to reduce the molar density of the detonation gas.
- [c12] The apparatus of claim 11 wherein the reactant is selected from the group consisting of Al, Ca, Li, Mg, Ta, Ti, Zr, and combinations thereof.
- [c13] The apparatus of claim 1 wherein the pressure reducer includes a pressure compression section in functional connection with a gun.
- [c14] The apparatus of claim 13 wherein the compression section includes a compressible material.
- [c15] The apparatus of claim 14 wherein the compressible ma-

terial is a spring.

- [c16] The apparatus of claim 14 wherein the compressible material is a solid.
- [c17] The apparatus of claim 14 wherein the compressible material is a fluid.
- [c18] The apparatus of claim 5 wherein the pressure reducer is positioned proximate the perforating gun.
- [c19] The apparatus of claim 11 wherein the pressure reducer is positioned proximate the perforating gun.
- [c20] The apparatus of claim 14 wherein the pressure reducer is positioned proximate the perforating gun.
- [c21] The apparatus of claim 5 wherein the pressure reducer is positioned disposed in the perforating gun.
- [c22] The apparatus of claim 11 wherein the pressure reducer is positioned disposed in the perforating gun.
- [c23] The apparatus of claim 14 wherein the pressure reducer is positioned disposed in the perforating gun.
- [c24] The apparatus of claim 51 wherein the pressure reducer is part of the perforating gun.
- [c25] The apparatus of claim 11 wherein the pressure reducer

is part of the perforating gun.

- [c26] The apparatus of claim 14 wherein the pressure reducer is part of the perforating gun.
- [c27] An apparatus for reducing the post-detonation pressure of a perforating gun, the apparatus comprising:
 - a perforating gun carrying at least one explosive charge, wherein when the explosive charge is detonated the explosive charge produces a pressurized detonation gas;
 - a temperature reducer in functional connection with the perforating gun, the temperature reducer adapted for reducing the temperature of the detonation gas; and
 - a molar density reducer in functional connection with the perforating gun, the molar density reducer adapted for reducing the molar density of the detonation gas.
- [c28] The apparatus of claim 37 wherein the temperature reducer is positioned in the perforating gun.
- [c29] The apparatus of claim 37 wherein the temperature reducer is positioned in the perforating gun.
- [c30] The apparatus of claim 37 wherein the temperature reducer is part of the perforating gun.
- [c31] The apparatus of claim 37 wherein the molar density re-

ducer is positioned proximate the perforating gun.

- [c32] The apparatus of claim 37 wherein the molar density reducer is positioned in the perforating gun.
- [c33] The apparatus of claim 37 wherein the molar density reducer is part of the perforating gun.
- [c34] The apparatus of claim 27 wherein the temperature reducer includes a heat sink adapted for rapidly reducing the temperature of the detonation gas.
- [c35] The apparatus of claim 34 wherein the heat sink has a high thermal conductivity.
- [c36] The apparatus of claim 34 wherein the heat sink has a large heat capacity.
- [c37] The apparatus of claim 34 wherein the heat sink includes copper.
- [c38] The apparatus of claim 34 wherein the heat sink includes water.
- [c39] The apparatus of claim 34 wherein the heat sink includes microencapsulated water beads.
- [c40] The apparatus of claim 27 wherein the molar density reducer is a reactant adapted for recombining with the detonation gas to form solids.

- [c41] The apparatus of claim 34 wherein the molar density reducer is a reactant adapted for recombining with the detonation gas to form solids.
- [c42] The apparatus of claim 27 wherein the temperature reducer and the molar density reducer include a pressure compression section in functional connection with a gun chamber.
- [c43] The apparatus of claim 42 wherein the compression section includes a compressible material.
- [c44] The apparatus of claim 40 wherein the temperature reducer and the molar density reducer include a pressure compression section in functional connection with a gun chamber.
- [c45] The apparatus of claim 41 wherein the temperature reducer and the molar density reducer include a pressure compression section in functional connection with a gun chamber.
- [c46] A method of reducing the post-detonation pressure of a perforating gun comprising the steps of:
 - providing a perforating gun having explosive charges;
 - detonating the explosive charges producing a pressurized detonation gas; and

reducing the detonation gas pressure proximate the perforating gun to encourage a surge flow from a reservoir formation.

- [c47] The method of claim 46 wherein the detonation gas pressure is reduced by rapidly reducing the temperature of the detonation gas.
- [c48] The method of claim 46 wherein the detonation gas pressure is reduced by reducing the molar density of the detonation gas.
- [c49] The method of claim 47 wherein the detonation gas pressure is reduced by reducing the molar density of the detonation gas.
- [c50] The method of claim 46 wherein the step of reducing the detonation gas pressure includes providing a heat sink in functional connection with the perforating gun adapted for reducing the temperature of the detonation gas.
- [c51] The method of claim 46 wherein the step of reducing the gas pressure includes the providing a compression section in functional connection with the perforating gun for reducing the pressure of the detonation gas.
- [c52] The method of claim 46 wherein including the step of reducing the gas pressure includes providing a reactant

adapted for recombining with the detonation gas to form solids.

- [c53] The method of claim 50 wherein the heat sink includes copper.
- [c54] The method of claim 50 wherein the heat sink includes water.
- [c55] The method of claim 51 wherein the compression section includes a compressible spring.
- [c56] The method of claim 51 wherein the compression section includes a compressible fluid.
- [c57] The method of claim 51 wherein the compression section includes a compressible solid.
- [c58] The method of claim 51 wherein the reactant is selected from the group consisting of Al, Ca, Li, Mg, Ta, Ti, Zr, and combinations thereof.